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ABSTRACT

In recent years, great interest has been generated in the determinants of science achievement. This study examines some of the postulated determinants of science achievement at the elementary level. The determinants examined are gender, parental occupation, socio-economic status, school gender, and school type. The 977 students who served as subjects were randomly selected from approximately 20,000 Trinidadian students who wrote the 11+ examination in March 1989. They were spread among 9 denominational and 6 government schools, were equivalent to the U.S. grade 6, and had taken 7 years of elementary schooling. Overall, the results indicate that numerous factors appear to influence the achievement of elementary school students. Since many negative factors appear to be correlated with home background, it was recommended that this should be the starting point of intervention. (CW)

DETERMINANTS OF SCIENCE ACHIEVEMENT AT THE ELEMENTARY LEVEL IN A "MINORITY" POPULATION

by

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DETERMINANTS OF SCIENCE ACHIEVEMENT AT THE ELEMENTARY LEVEL IN A "MINORITY" POPULATION

In recent years great interest has been generated in the determinants of science achievement. According to Becker (1989) researchers have tried to relate differences in science achievement to differences on other potential constructs such as science for self-concept, liking for science, general intelligence and various cognitive abilities and aptitudes. Another common focus of research on science achievement has been the prediction of achievement from affective, cognitive and demographic variables; gender has sometimes been included a predictor.

The relationship of gender to participation and performance in science has generated considerable interest. Researchers have studied gender differences in science achievement to determine whether in fact such differences do exist and if so to what extent. Using studies from the Science Meta-Analysis Project, Kahl (1982) examined the intercorrelations of student characteristics and science outcomes as well as simple gender differences in science. He noted (on the basis of average correlations) that gender was a weaker predictor of science outcomes than were ethnicity, race, and a host of cognitive-ability measures. The findings held regardless of the grade level of the students.

Most researchers believe that the disparity in achievement comes from differences in the in-school and out-of-school activities of boys and girls. As Linn (1986) suggests, differential participation in, or access to, informal learning experiences contribute to the different worldviews students bring to science learning environments. For example, girls are less likely than boys to participate in science related out-of-school activities. Learners from lower socio-economic status groups are less likely to have science related informal learning experiences. Population groups such as women and the underpriveleged are less likely to gain access to technology and less likely to be exposed to exemplary programs when they do have technological access. Such differences in experience have implications for performance in formal education settings, because students lacking informal learning opportunities may have less powerful or appropriate intuitive ideas about the curriculum. By encouraging and providing informal science experiences for all students, we can enhance lifelong science learning.

At the international level, cross-national differences in attitudes towards women are evident in national stereotypes and may subtly influence girls' achievement in science (Abder, Gann and Hann; 1987,; Hamilton,1985). According to Klein (1989), in Saudi Arabia where society limits the acceptable career choices for women, only 5% of women pursue science-related careers,while in Poland where

societal views differ, about 60% of women enter science-related fields. Fraser-Abder (1986) in her study of Trinidadian elementary subjects, found that females achieved better than males and that the gender of peers affected achievement in females. At the national level, Steinkamp and Maehr (1983) in their review of 18 correlational studies found that males achieved higher in science than do females. Gender differences were found to be smaller for studies of younger subjects increasing to a maximum average correlation of 0.28 for studies of junior high students.

This study examines some of the postulated determinants of science achievement at the elementary level. The determinants examined are gender, parental occupation, socio-economic status, school gender, and school type. If linkages are found to exist with adverse effects on science achievement, then, science educators and curriculum developers should take this interaction into account when developing learning materials and teaching and learning opportunities for students at this level.

Subjects

In the U.S. context the population sampled would be termed "minority" or non-white; however this term is not used in the Trinidadian setting. The students are Trinidadian from varied backgrounds- African, Indian, Chinese, Syrian, British, etc. The teachers reflect the same mixture. The 977 students who served as

subjects were randomly selected from approximately 20,000 Trinidadian students who wrote the 11+ examination in March 1989. They were spread between 9 denominational and 6 government schools and were equivalent to the U.S. grade six and had taken seven years of elementary schooling. Table 1 shows a profile of the student sample.

TABLE 1

Profile of Student Sample

Determinant	Descriptors	No. of Students	
1.Student Gender	1. Boys	329	
	2. Girls	648	
2.School Gender	1. Boys	130	
	2. Girls	457	
	3. Co-educational	390	
3.School Type	1. Denominational	735	
	2. Government	242	
4.Socio-economic status	1. Unknown	30	
	2. Upper	65	
	3. Semi-upper	101	
	4. Middle	180	
	5. Semi-middle	320	
	6. Lower	281	
		mother	father
5.Parental Occupation	1. Unknown	147	153
	2. Prof/management	8	34
	3. Lower l. management	45	141
	4. Skilled occupation	48	81
	5. Semi-skilled occupation	175	238
	6. Unskilled occupation	484	297
	7. TEACHER	70	33

Instrument

The test used was the science section of the practice test given to all 11+ students in March 1989 in preparation for the Common Entrance Examination. This results of this examination determines the type of secondary school in which students are placed; science is one of the sections included in this examination. The practice test is conducted under controlled conditions and is marked by the class teacher. The results serve as an indication of the student's performance in the Common Entrance Examination. The results of the Common Entrance Examination were not available in the required format for this study.

Fifteen (15) Grade 6 teachers from the 15 randomly selected schools were asked to supply the researcher with the following information on each student:

(a) Practice test science score.

(b) Student gender.

(c) School gender.

(d) School type.

(e) Occupation of mother and father.

(f) Socio-economic status.

Analysis of the data obtained revealed the effect of the following on science achievement:

Student Gender

This is the relationship which has been most widely researched by the international community.

How do the results obtained in Trinidad compare with international findings?

Is there a relationship between student gender and science achievement by the end of elementary school?

Tables 2 and 3 show the relationship which exists between gender and science achievement in the population sampled.

TABLE 2

Comparison of the mean score of male and female students

Statistic	Male	Female	t test
N	329	648	
S.E.	0.30230	0.20678	df=975
X	13.796	16.515	66.04676***

TABLE 3

Chi-square analysis for male and female students

Science score	Male	Female	Total	Chi square
0-5	21	23	44	
6-10	84	71	155	55.90
11-15	92	155	247	
16-20	86	223	309	c=0.233
21-25	46	176	222	

The results of the chi square and the contingency coefficient indicate that there is a significant association between student gender and science achievement, with girls having higher achievement scores than boys.

School Gender.

Many studies (Kaminski,1982), (Steinkamp,1984), have compared achievement in single sex schools with that in co-educational schools. The achievement level of girls in single sex schools was generally better than that of girls or boys in co-ed schools or boys in single sex schools. Does this hold true in this sample? Tables 4 and 5 show the data analysis.

TABLE 4
Comparison of the mean score of students in single sex schools and co-educational schools

Statistic	All boys	All girls	Co-educational
N	130	457	390
S.E.	0.43499	0.20943	0.25998
X	16.262	18.109	12.438

TABLE 5

Chi-square analysis for students in single sex schools and co-educational schools.

Science score	All male	All female	Co-ed	Total	Statistic
0-5	1	5	38	44	
6-10	20	26	109	155	
11-15	33	88	126	247	207.65***
16-20	46	177	86	309	c=0.419
21-25	30	161	31	222	

The results indicate that there is a significant association between school gender and science achievement with girls from all-girls schools achieving higher than other groups.

School Type.

Is there a difference in achievement between students attending public versus private schools? Table 6 shows the data analysis for effect of school type on achievement.

TABLE 6

Comparison of the mean score of students in private (denominational) and public (government) schools

Statistic	Denominational	Government	t test
N	735	242	df=975
S.E.	0.17746	0.30417	t=28.63***
X	17.137	10.930	

Analysis of variance results indicate that there is a significant difference between scores of students attending private schools and those attending public schools (F=271.33***).

Data analysis for the relationship between school gender, student gender and science achievement score were all at the .001 level of significance-school gender F=36.85*** and student gender F=74.17***. The results indicate that the girls in all girl schools are achieving better than boys in single sex or students in co-educational schools.

It appears that there is indeed some significant linkage between gender and science achievement in favor of the girls (Grade 6). These results appear to be culture specific to the sample in the study. It is noteworthy to mention that in spite of this performance by girls at this level, not many girls opt to do science at secondary school. Researchers and curriculum developers need to investigate the reason for this phenomenon and devise strategies for reversing this trend.

Parental Occupation

Does parental occupation influence in any way the science achievement of their children? Tables 7,8 and 9 show the mean score, chi-square and analysis of variance of students whose

parents are classified in the seven occupations.

TABLE 7

Mean score and Chi-square analysis for students by father's occupation

Score	0	1	2	3	4	5	6	T	Chi square
0-5	6	0	2	1	11	24	0	44	
6-10	23	0	13	9	42	68	0	155	170.65***
11-15	41	0	27	14	60	102	3	247	
16-20	49	8	49	28	83	79	13	309	c=0.386
21-25	34	26	50	29	42	24	17	222	
total	153	34	141	81	238	297	33	977	
X	15.5	21.7	17.7	17.7	15.2	13.2	20.1		
S.E.	0.43	0.45	0.42	0.54	0.35	0.29	0.59		

TABLE 8

Mean score and Chi-square analysis for students by mother's occupation

Score	0	1	2	3	4	5	6	T	Chi square
0-5	8	0	1	0	7	28	0	44	
6-10	35	0	4	7	23	84	2	155	122.35***
11-15	39	0	11	6	42	144	5	247	
16-20	44	2	10	16	60	154	23	309	c=0.386
21-25	21	6	19	19	43	74	40	222	
total	147	8	45	48	175	484	70	977	
X	14.2	21.3	17.1	18.0	16.1	14.7	20.4		
S.E.	0.46	1.19	0.79	0.73	0.40	0.24	0.43		

TABLE 9

Analysis of variance of science score /parental occupation

Variable	SS	DF	MS	F
Father's occupation	4700	6	783.3	33.21***
Mother's occupation	1710	6	285	12.08***
Father's occupation/ Mother's occupation	980	31	31.61	1.34 NS
Error	22010	933	23.59	
Total	29400	976		

The results indicate that parental occupation significantly affected the student's science score. However, there was no significant difference between the effect of the maternal and paternal occupation. Students whose parents are teachers are placed in section six (6). Since there is a tendency for parents who are teachers to help their children at home it was thought useful to determine whether this factor provided a significant difference to the score of these students. The results did indicate that these students scored significantly better than students in five other categories but lower than students whose parents were categorised as professional or managerial.

Researchers should attempt to determine the underlying reasons for this difference, perhaps one factor that might account for the difference is the out-of-school experience provided for these students.

Socio-economic Status.

Does socio-economic status influence in any way the science achievement of students at this level? Table 10 shows the mean score and chi-square data for students who are classified in the six socio-economic categories identified in Table 1.

TABLE 10

Mean score and Chi-square analysis for students by socio-economic status

Score	0	1	2	3	4	5	T	Chi square
0-5	4	0	1	1	17	21	44	
6-10	10	1	6	21	56	61	155	211.52***
11-15	10	4	18	30	84	101	247	
16-20	6	18	33	66	113	73	309	c=0.422
21-25	0	42	43	62	50	25	222	
Total	30	65	101	180	320	281	977	
X	11.1	20.8	18.5	17.6	14.9	13.3		
S.E.	0.87	0.42	0.46	0.36	0.30	0.30		

It would appear that socio-economic status significantly affects science achievement at this level in the population sampled.

Overall the results indicate that numerous factors appear to influence the achievement of elementary school students: student gender, schoool type, school gender, parental occupation and socio-economic status. Since many negative factors appear to be correlated with home background then this area should be the starting point of our attack. We need to get parents more actively involved in what their children are doing in school. The community needs to offset the negative influence of the home by providing

science related informal learning experiences for boys and girls e.g.television,museums, interaction with scientists.

It is unfortunate though that in spite of the higher achievement by females at this level, the secondary school system and the community fail to encourage girls to pursue careers in science. A research agenda for secondary science education researchers should look at two important issues:

What are the determinants of science selection and achievement at the secondary level?

What causes science avoidance by females when they enter secondary school?

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